Nikon

Metallurgical Microscope
OPTIPHOT

INSTRUCTIONS

NIPPON KOGAKU K.K.

CAUTIONS

1. When carrying the microscope, hold its arm with one hand, supporting the bottom of the microscope base with the other.
   The instrument weighs about 8 kg.
2. Take care that some parts of the lamp housing may take a considerable high temperature, while the lamp is being lighted.
3. In such cases as of replacement, do not touch the lamp bulb with bare hands, immediately after putting out the lamp.
4. Do not bring inflammable substances such as gasoline, thinner, and alcohol near to the lamp housing, while the lamp is being lighted.
5. Handle the microscope gently, taking care to avoid sharp knocks.
6. Avoid the use of the microscope in a dusty place, where it is subject to vibrations or exposed to high temperatures, moisture or direct sunlight.
7. Do not leave dust, dirt or finger marks on the lens surfaces.
8. Make sure of the power source voltage, seeing the indication on the transformer:

LINE 120V 50/60Hz Lamp 6V 20W

   or

LINE 220/240V 50/60Hz Lamp 6V 20W

   In European district, set the correct voltage, 220 or 240V, by means of the change-over switch on the bottom of the transformer.
9. Before replacing the fuse, disconnect the plug of the power source cord.
10. Never attempt to adjust the tightness of the right- and lefthand focus knobs by turning the one, while holding the other in this model microscope, because of causing disorder.

CARE AND MAINTENANCE

1. To clean the lens surfaces, remove dust using a soft hair brush or gauze. Only for removing finger marks or grease, should soft cotton cloth, lens tissue or gauze lightly moistened with absolute alcohol (methanol or ethanol) be used.
   For cleaning the objectives and immersion oil use only xylene. For cleaning the surface of the entrance lens of the eyepiece tube and the prism surface of the Trinocular Eyepiece Tube "T" or the Ultra Wide Eyepiece Tube "UW", use absolute alcohol. Observe sufficient caution in handling alcohol and xylene.
2. Avoid the use of any organic solvent (for example, thinner, ether, alcohol, xylene etc.) for cleaning the painted surfaces and plastic parts of the instrument.
3. Never attempt to dismantle the instrument so as to avoid the possibility of impairing the operational efficiency and accuracy.
4. When not in use, cover the instrument with the accessory vinyl cover, and store it in a place free from moisture and fungus.
   It is especially recommended that the objectives and eyepieces be kept in an airtight container containing desiccant.

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I . NOMENCLATURE

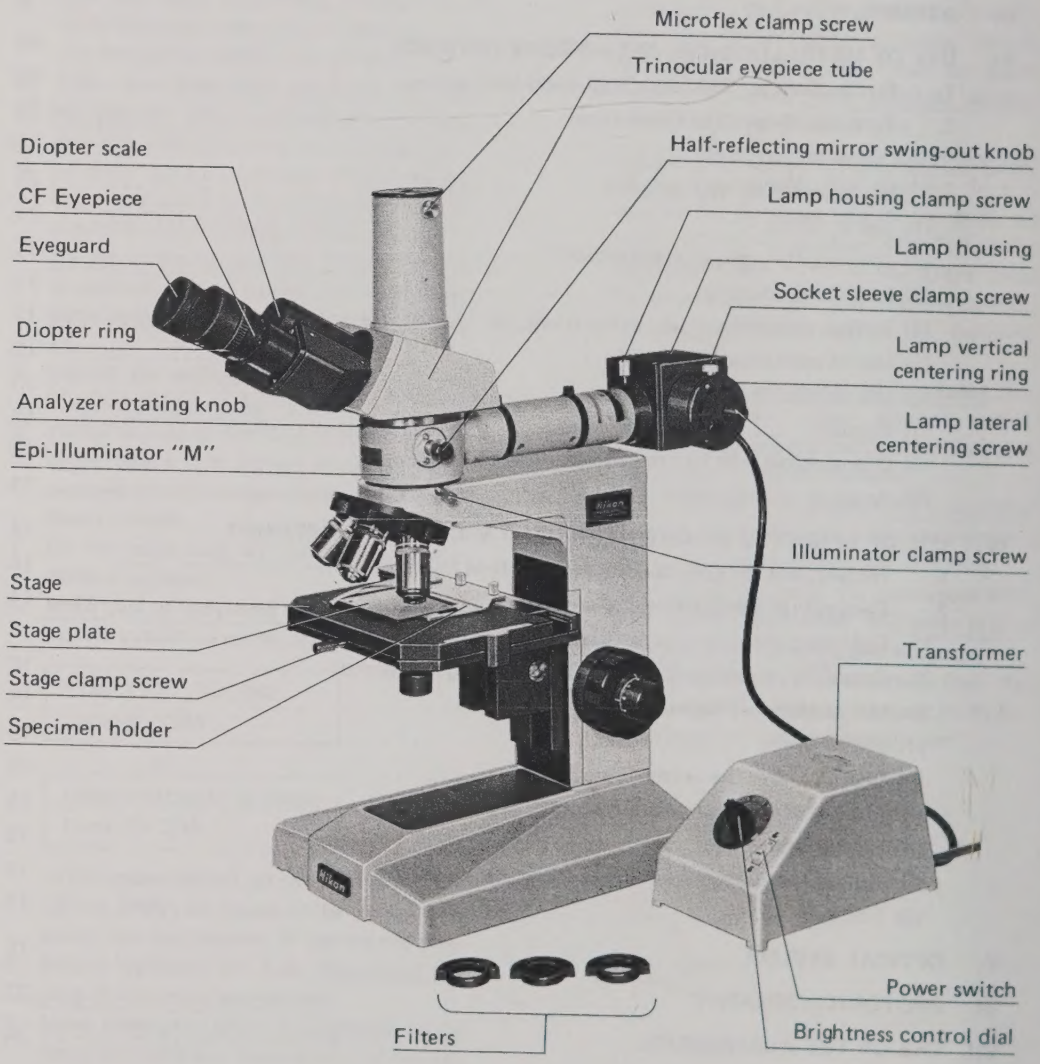


Fig. 1

Metallurgical Microscope OPTIPHOT

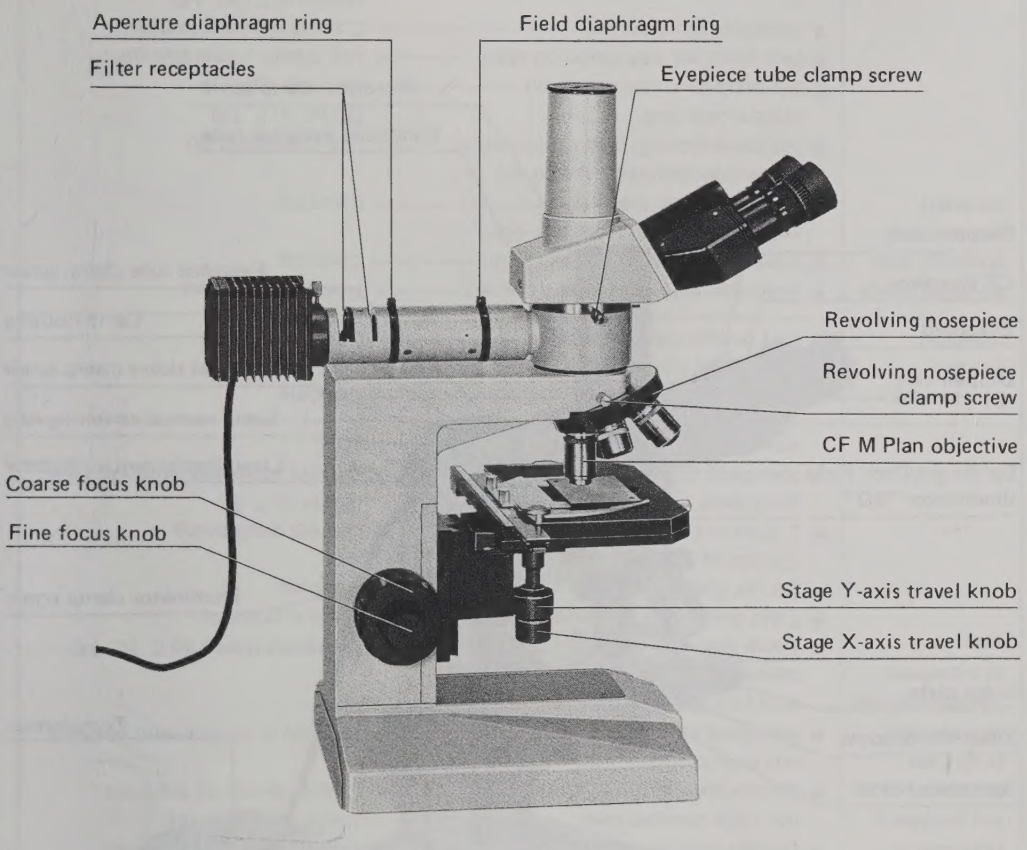

Aperture diaphragm ring
Filter receptacles
Field diaphragm ring
Eyepiece tube clamp screw
Revolving nosepiece
Revolving nosepiece clamp screw
CF M Plan objective
Coarse focus knob
Fine focus knob
Stage Y-axis travel knob
Stage X-axis travel knob

Fig. 2

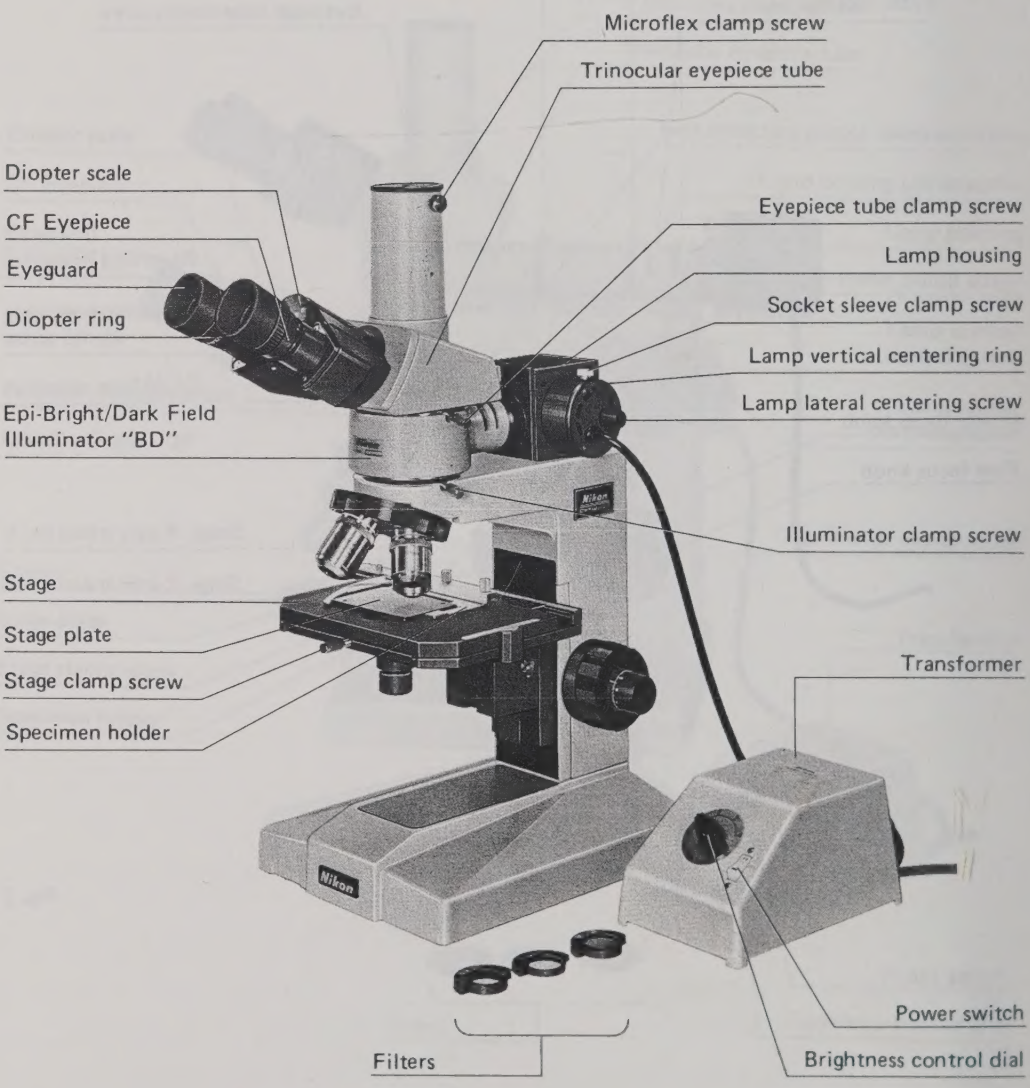


Fig. 3

Episcopic Bright/Darkfield Microscope OPTIPHOT

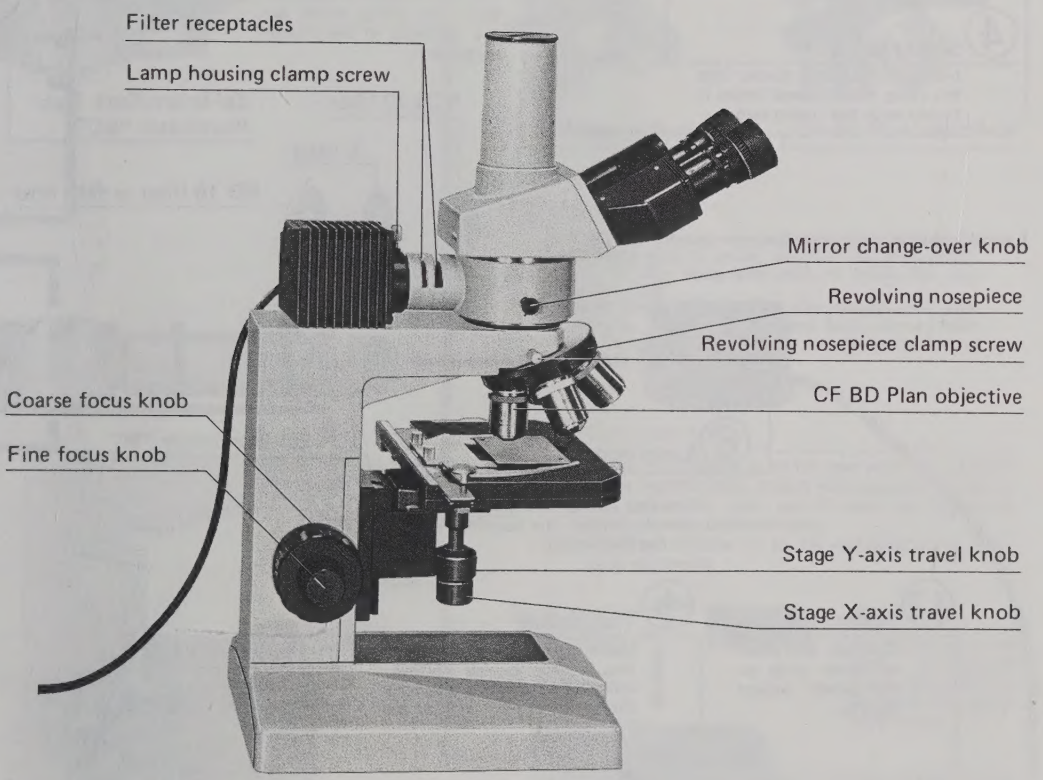
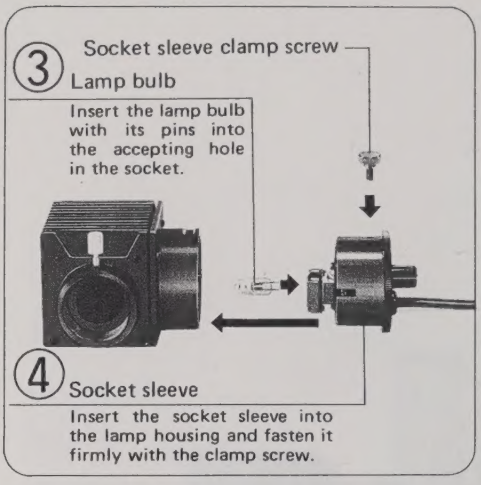

Filter receptacles
Lamp housing clamp screw
Mirror change-over knob
Revolving nosepiece
Revolving nosepiece clamp screw
CF BD Plan objective
Coarse focus knob
Fine focus knob
Stage Y-axis travel knob
Stage X-axis travel knob

Fig. 4

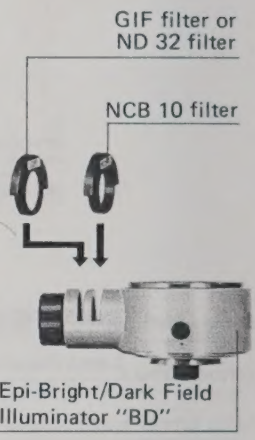
II. ASSEMBLY

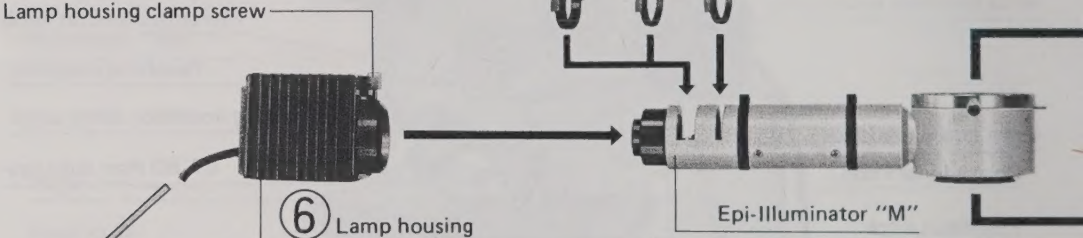
- For assembling the Metallurgical Microscope OPTIPHOT or the Episcopic Bright/Darkfield Microscope OPTIPHOT, follow the procedure in the order given below:


③ Socket sleeve clamp screw
Lamp bulb
Insert the lamp bulb with its pins into the accepting hole in the socket.
④ Socket sleeve
Insert the socket sleeve into the lamp housing and fasten it firmly with the clamp screw.

⑤ Illuminator

For the Metallurgical Microscope OPTIPHOT, attach the Epi-Illuminator "M" to the microscope arm, with the half-reflecting mirror swing-out knob faced right, but for the Episcopic Bright/Darkfield OPTIPHOT, attach the Epi-Bright/Dark Field Illuminator "BD" to the arm with the mirror change-over knob faced left.
In either case, fasten up the illuminator in position with the clamp screw on the rightside of the microscope arm.


GIF filter or ND 32 filter
NCB 10 filter
NCB 10 filter
L filter
ND 16 filter or GIF filter
Epi-Bright/Dark Field Illuminator "BD"



⑥ Lamp housing

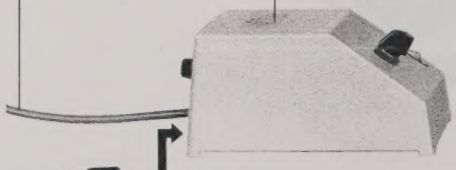
After releasing the lamp housing clamp screw sufficiently, attach the housing to the illuminator.

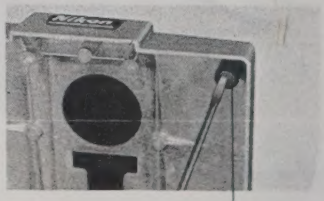
⑬ Power source cord

Connect the power input plug to the power source socket.

① Transformer

Make sure of the correct setting of the power voltage, referring to the indication on the transformer. (Refer to P.2-8.)





② Leveling foot screw

For stable installation of the microscope, manipulate the adjusting screw at one foot on the bottom of the microscope base.

⑫ Power output plug

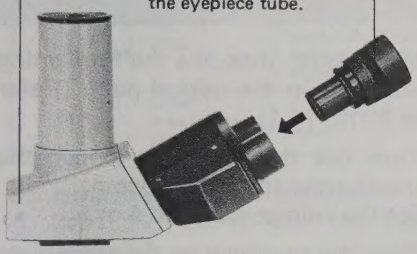
Connect the power output plug to the output socket on the transformer.

⑦ Eyepiece tube

Attach the eyepiece tube to the illuminator with the Microflex clamp screw on the vertical photo tube faced right. Fasten up the eyepiece tube with the clamp screw on the leftside of the Epi-Illuminator "M" or on the rightside of the Epi-Illuminator "BD".

⑧ Eyepiece

Insert the eyepieces into the eyepiece sleeves of the eyepiece tube.

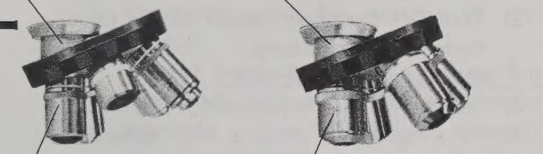


⑪ Revolving nosepiece

Lower the stage by manipulating coarse focus knob. Take the nosepiece with 5 holes for the Epi-Illuminator "M" or the nosepiece with 4 holes for the Epi-Illuminator "BD".
Releasing the revolving nosepiece clamp screw sufficiently, insert the nosepiece. Making sure of positive fitting of the pin on the microscope arm into the nosepiece groove, refasten the clamp screw.

Revolving nosepiece with 5 holes

Revolving nosepiece with 4 holes for Illuminator "BD"

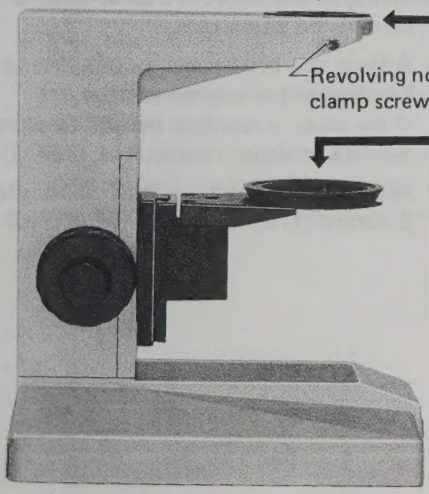


CF M Plan objectives

CF BD Plan objectives

⑩ Objectives

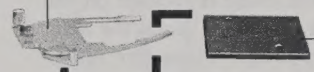
CF M Plan objectives are to be attached to the nosepiece with 5 holes, and CF BD Plan objectives, to the nosepiece with 4 holes for Illuminator "BD".
Mount these objectives on the nosepiece in such positions, that, when, viewed from above, their magnifying power increases as the nosepiece is revolved clockwise.



Revolving nosepiece clamp screw

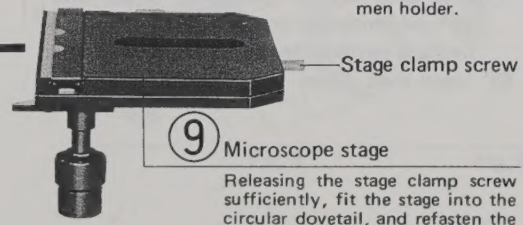
Specimen holder

If the microscope is to be used with the lefthand stage travel knobs, attach the specimen holder to the righthand hole, and if with the righthand knobs, to the lefthand hole.
Specimen holder is to be removed when using large specimen.



Stage plate

Place the plate on the microscope stage and fasten it up with the specimen holder.



Stage clamp screw

⑨ Microscope stage

Releasing the stage clamp screw sufficiently, fit the stage into the circular dovetail, and refasten the clamp screw.

Fig. 5

III. USE OF METALLURGICAL MICROSCOPE OPTIPHOT

1. Preparations for Episcopic Brightfield Microscopy

Centering the lamp

1) Turn the half-reflecting mirror swing-out knob counterclockwise to the position where the indication "IN" comes to the operator's side, to bring the mirror into the optical path.
2) Turn ON the power switch on the transformer to light the lamp.
   Set the voltage meter to 3.
3) Remove the L filter (diffuser).
4) As a specimen, place a high reflection subject or ND 16 filter (available as accessory) on the stage. Using the objective 10×, bring the image of the specimen nearly into focus.
   A low reflection specimen or too high a voltage may produce not so distinct image of the filament. In this case, use the ND 16 filter as a specimen.
5) Draw out an eyepiece from either of the observation tubes on the trinocular eyepiece tube. Look into the tube, and the image of the exit pupil of the objective will be visible as a bright circle, together with the surface of the diffuser built in the illuminator.
   Move the lamp housing back and forth, until the filament image is focused on the diffuser and the exit pupil. Lock the lamp housing in this position. Thereafter, releasing the socket sleeve clamp screw, rotate the lamp lateral centering screw and vertical centering ring, so that the filament image is centered to the exit pupil.
6) Insert the L filter.

2. Episcopic Brightfield Microscopy

1) Operating Procedure

(1) Make sure that the half-reflecting mirror is in the optical path. (Refer to P. 10 1 - 1)

(2) Turn ON the power switch on the transformer to light the lamp.
Set the voltage meter to 4 or 5.

(3) Place the specimen on the stage plate and focus on the specimen using 10× objective.

(4) Adjust the interpupillary distance and diopter. (Refer to P.11 2) - (2), (3))

(5) Make sure of correct illumination. (Refer to P. 10 1 - 5))

(6) Insert the filters to be used.
Insert the L filter and for general microscopy, add the NCB 10 filter and ND 16 filter.

(7) Swing in the objective to be used and refocus on specimen.

(8) Adjust the brightness by ND filter or by changing the lamp voltage.
If the image is too dark through an objective 40× or higher, remove the L filter.

(9) Adjust the aperture and field diaphragms. (Refer to P.12 (5) and (6))

2) Manipulation of each element

(1) Use of filters

The accessory filters are as shown below:

Table 1. Use of Filters

Indication	Type of filter	Use
L	Diffuser	To be inserted in all cases except for lamp centering
NCB 10	Color balancing filter	For general microscopy and color photomicrography
ND 16	ND 16 filter (T = 6.25%)	For general microscopy and brightness adjustment in photomicrography
GIF	Green interference filter	For contrast adjustment

(2) Interpupillary distance adjustment

① Insert the NCB 10 filter into the filter receptacle.

② As shown in Fig. 6, adjust the interpupillary distance, so that both the right and left viewfield become one.

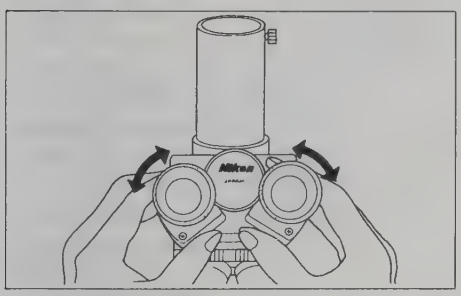


Fig. 6

(3) Diopter adjustment

Make diopter adjustment for both the right and lefthand eyepieces.

① Turn the diopter ring on each eyepiece, until the end surface of the milled ring coincides with the engraved line, as shown in Fig. 7.

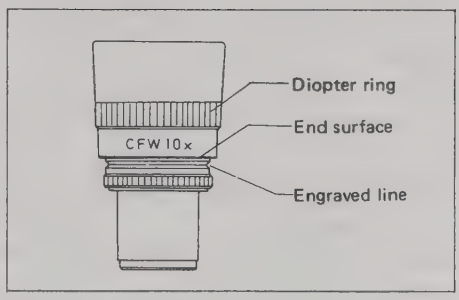


Fig. 7

② Mount the specimen on the stage plate. Swing the objective 40× into position, and bring the specimen image into focus. For facilitating the focusing, first use the 10× and then 40× objective.

③ Thereupon, swing the objective 5× into position.

Without manipulating the coarse-and-fine focus knob, turn the diopter rings on the eyepieces, so that the specimen images in the right and lefthand eyepieces are focused individually.

- Repeat the above procedure two times, and a perfect diopter adjustment will be achieved.
- The above adjustment, compensating the diopter difference between the user's right and left eyes, will keep the tube length of microscope correct, thus enabling him to realize the full advantages of the high-class objectives, including their parfocality.

④ Since the CF eyepieces are of high eyepoint type, it is not necessary for the user putting on his spectacles to remove them. Only fold down the eyeguard rubber.

(Fig. 9)

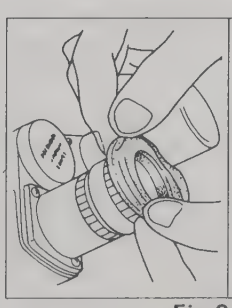


Fig. 8

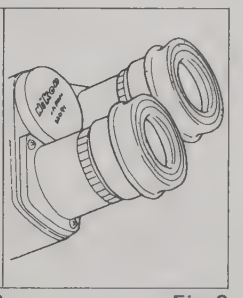


Fig. 9

(4) Optical path change-over in the trinocular eyepiece tube

① When using the trinocular eyepiece tube "F"

As shown in Fig. 10, when the observation tube is turned toward the user, 100% of light enters the observation tube.

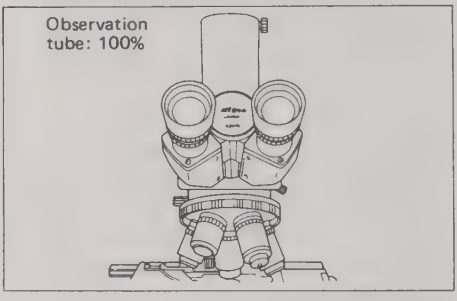


Fig. 10

As shown in Fig. 11, when the observation tube is revolved 60° leftward, 100% of light enters the vertical photo tube.

In either case, turn the tube to the limit.

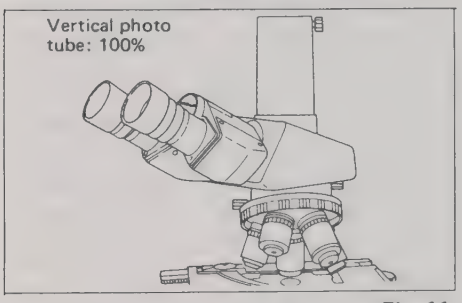


Fig. 11

② When using the trinocular eyepiece tube "T" and the ultra wide eyepiece tube "UW"

As shown in Fig. 12, with the change-over knob pushed in, 100% of light enters the observation tube.

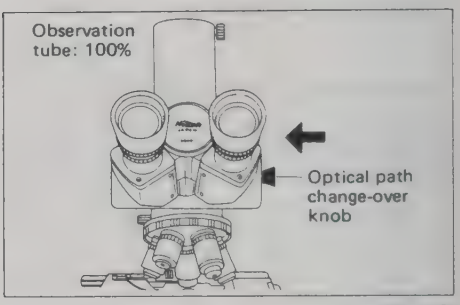


Fig. 12

As shown in Fig. 13, with the change-over knob drawn out, the proportion of light entering the observation tube and photo tube will be 14 : 86.

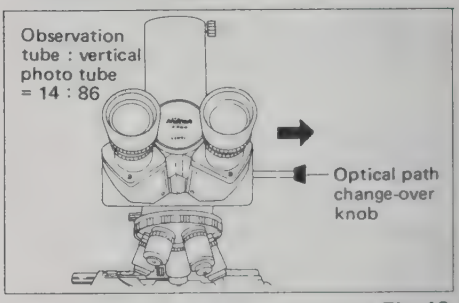


Fig. 13

(5) Use of aperture diaphragm

The aperture diaphragm is provided for adjusting the numerical aperture (N.A.) of the illuminating system of microscope. It is important because it determines the resolution, contrast and depth of focus. In general, when it is stopped down to 70 ~ 80% of the numerical aperture of the objective, a good image of appropriate contrast will be obtained. (Fig. 14)

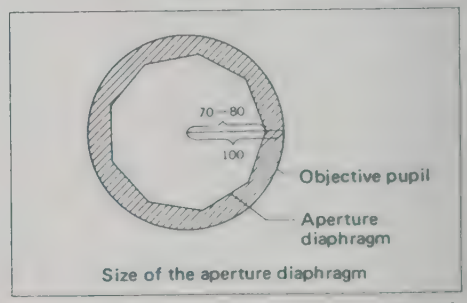


Fig. 14

After removing the eyepiece from the eyepiece tube, adjust the size of the diaphragm, observing the image of the diaphragm which is visible on the bright circle of exit pupil of objective inside the eyepiece tube.

Stopping down the aperture diaphragm too far will deteriorate the image quality of microscope due to diffraction of light. Therefore, it is not recommended to stop down the aperture to a size smaller than 60% of the N.A. of the objective in use except when observing special specimens.

(6) Use of field diaphragm

The field diaphragm is used for determining the illuminated area on the specimen surface in relation to the field of view of the microscope.

Generally, it is stopped down to such an extent that the circumference of the illuminated area circumscribes or inscribes that of the eyepiece field of view. If the former be larger than the latter, extraneous light will enter the field of view, causing flare in the image and lowering the contrast. Therefore, especially in photomicrography, the proper adjustment of the field diaphragm is very important.

Generally, good results will be achieved when the diaphragm is stopped down to such an extent that the diameter of illuminated area is slightly larger than the diagonal of film format.

(7) Focusing

The relation between the direction of rotation of the focus knobs and that of vertical movement of the stage is as indicated in Fig. 15.

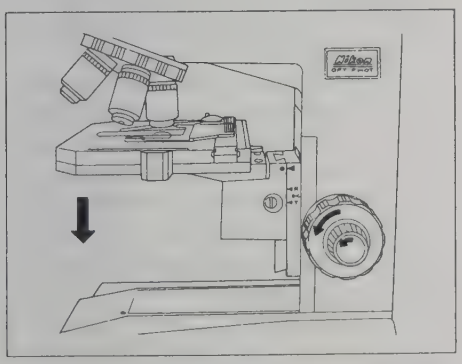


Fig. 15

One rotation of the fine focus knob moves the stage 0.1mm. The graduation on this focus knob is divided into 1 μm. One rotation of the coarse focus knob moves the stage 4.7mm.

The range of coarse and fine motion is within 30mm; 2mm up and 28mm down from the standard position.

Tightness of the coarse-fine focus knob having been properly adjusted by the manufacturer, it should never be readjusted in this model microscope by turning the one knob while holding the other.

(8) Changing-over the half-reflecting mirror

Half-reflecting mirror is to be brought into the optical path. But for diascopic microscopy, using the microscope stand with the built-in diascopic illuminator (especially for observing a specimen of high contrast such as IC masks), remove the half-reflecting mirror out of the optical path, rotating the mirror swing-out knob clockwise to turn the indication "OUT" toward the operator.

For simultaneous episcopic and diascopic microscopy, leave the half-reflecting mirror in the optical path.

(9) Analyzer rotating knob

In the case of ordinary microscopy, the analyzer rotating knob, which is to be manipulated with the polarizing filter set "PR" or differential interference contrast "NR", can be set at any position.

For the use of the analyzer rotating knob, refer to P. 24 or the instruction manual of Differential Interference Contrast "NR".

IV. USE OF EPISCOPIC BRIGHT/DARKFIELD MICROSCOPE OPTIPHOT

1. Preparations for Episcopic Bright/ Darkfield Microscopy

Centering the lamp

1) Push in the mirror change-over knob for darkfield illumination.
2) Turn ON the power switch on the transformer to light the lamp.
   Set the voltage meter to 6.
3) Swing out the objective and place a sheet of white paper on the stage.
4) On the white paper, a bright, illuminated ring will be imaged.
   Move the lamp housing back and forth, and, after releasing the socket sleeve clamp screw, rotate the lamp lateral centering screw and vertical centering ring, to make the ring image uniformly bright.

2. Episcopic Bright/Darkfield Microscopy

1) Operating procedure for episcopic darkfield microscopy

(1) Push in the mirror change-over knob to the limit.

(2) Turn ON the power switch on the transformer to light the lamp.
Set the voltage meter to 6.

(3) Insert the filters to be used.
For general microscopy, use the NCB 10 filter.

(4) Place the specimen on the stage plate. Focus on the specimen using 10× objective.

(5) Adjust the interpupillary distance and diopter. (Refer to P.15 3) - (3), (4))

(6) Make sure of correct illumination. (Refer to P.14 1 - 4))

(7) Swing in the objective to be used and refocus on specimen.
Though the BD 60× and BD 100× objectives are provided with a safety device, their top end lens surface being somewhat projected from the circumferential metal, be careful not to strike it against the specimen or others.
Furthermore, the characteristics (directionality, etc.) of the image produced by such objectives may be affected by the degree of centering of the lamp (light source). It is necessary to perform recentering of the lamp, watching the image.

(8) Adjust the brightness by changing the lamp voltage.

2) Operating procedure for episcopic brightfield microscopy

(1) Pull out the mirror change-over knob to the limit.

(2) Turn ON the power switch on the transformer to light the lamp.
Set the voltage meter to 4 or 5.

(3) Insert the filters to be used.
For general microscopy, use the NCB 10 filter and ND 32 filter.

(4) Place the specimen on the stage plate. Focus on the specimen using 10× objective.

(5) Adjust the interpupillary distance and diopter. (Refer to P.15 3) - (3), (4))

(6) Make sure of correct illumination. (Refer to P.14 1 - 4))

(7) Swing in the objective to be used and refocus on specimen.

(8) Adjust the brightness by ND filter or by changing the lamp voltage.

3) Manipulation of each element

(1) Use of filters

The accessory filters are as shown below:

Table 2. Use of Filters

Indication	Type of filter	Use
NCB 10	Color balancing filter	For general microscopy and color photomicrography
GIF	Green interference filter	For contrast adjustment
ND 32	ND 32 filter (T = 3%)	For dazzle-prevention when changing over the viewfield; bright from/to dark

Remove the ND 32 filter out of the optical path, when only the brightfield observation is to be made or the use of such a filter is not necessary on account of the type of specimen.

(2) Changing-over the mirror

To change-over the mirror to the brightfield from the darkfield or to the darkfield from the brightfield position, only manipulate the mirror change-over knob.

(3) Interpupillary distance adjustment

① Insert the NCB 10 filter into the filter receptacle.

② As shown in Fig. 16, adjust the interpupillary distance, so that both the right and left viewfield become one.

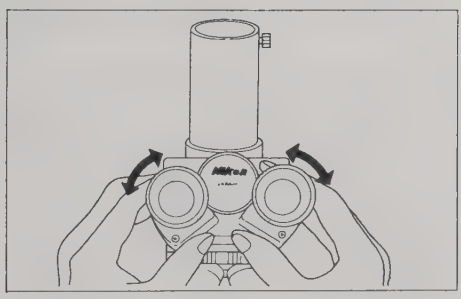


Fig. 16

(4) Diopter adjustment

Make diopter adjustment for both the right and lefthand eyepieces.

① Turn the diopter ring on each eyepiece, until the end surface of the milled ring coincides with the engraved line, as shown in Fig. 17.

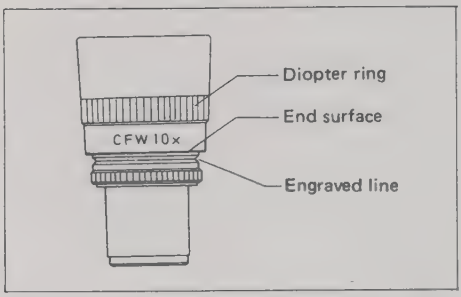


Fig. 17

② Mount the specimen on the stage plate. Swing the objective 40× into position, and bring the specimen image into focus. For facilitating the focusing, first use the 10× and then 40× objective.

③ Thereupon, swing the objective 5× into position.
Without manipulating the coarse-and-fine focus knob, turn the diopter rings on the eyepieces, so that the specimen images in the right and lefthand eyepieces are focused individually.

- Repeat the above procedure two times, and a perfect diopter adjustment will be achieved.
- The above adjustment, compensating the diopter difference between the user's right and left eyes, will keep the tube length of microscope correct, thus enabling him to realize the full advantages of the high-class objectives, including their parfocality.

④ Since the CF eyepieces are of high eyepoint type, it is not necessary for the user putting on his spectacles to remove them.
Only fold down the eyeguard rubber.
(Fig. 19)

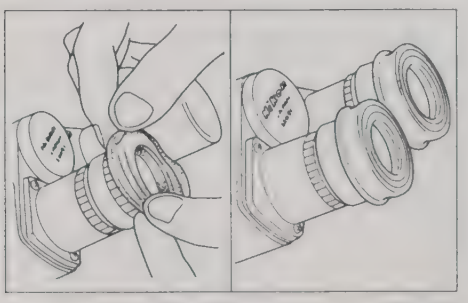


Fig. 18 Fig. 19

(5) Optical path change-over in the trinocular eyepiece tube

① When using the trinocular eyepiece tube "F"
As shown in Fig. 20, when the observation tube is turned toward the user, 100% of light enters the observation tube.

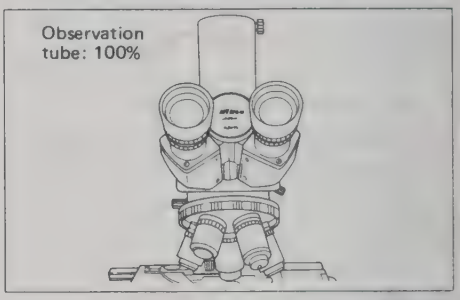


Fig. 20

As shown in Fig. 21, when the observation tube is revolved 60° leftward, 100% of light enters the vertical photo tube.
In either case, turn the tube to the limit.

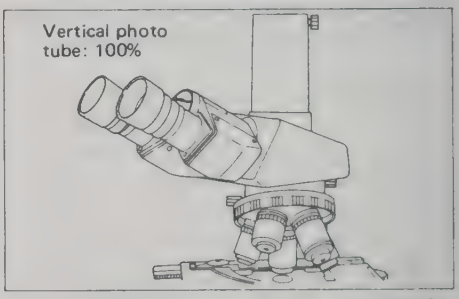


Fig. 21

② When using the trinocular eyepiece tube "T" and the ultra wide eyepiece tube "UW"
As shown in Fig. 22, with the change-over knob pushed in, 100% of light enters the observation tube.

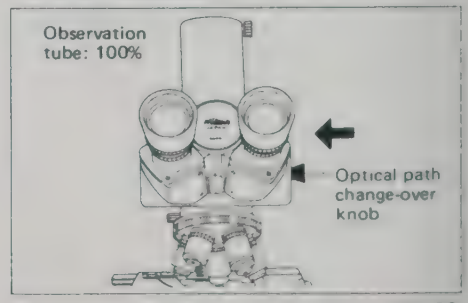


Fig. 22

As shown in Fig. 23, with the change-over knob drawn out, the proportion of light entering the observation tube and photo tube will be 14 : 86.

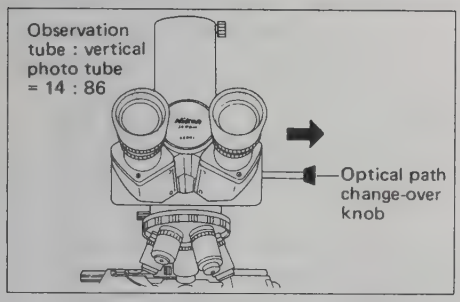


Fig. 23

(6) Focusing

The relation between the direction of rotation of the focus knobs and that of vertical movement of the stage is as indicated in Fig. 24.

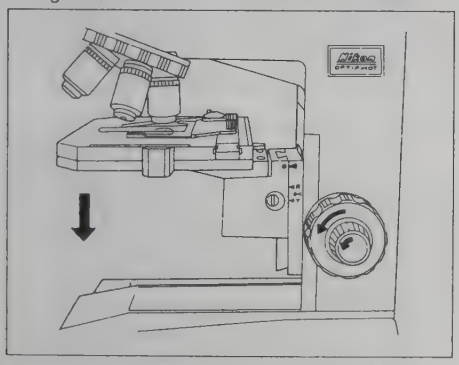


Fig. 24

One rotation of the fine focus knob moves the stage 0.1mm.

The graduation on this focus knob is divided into 1 μm.

One rotation of the coarse focus knob moves the stage 4.7mm.

The range of coarse and fine motion is within 30mm; 2mm up and 28mm down from the standard position.

Tightness of the coarse-fine focus knob having been properly adjusted by manufacturer, it should never be readjusted in this model microscope by turning the one knob while holding the other.

V. OPTICAL SYSTEM

The CF objectives and CF eyepieces adopted in the Nikon Metallurgical Microscope OPTIPHOT are designed on the basis of a new Nikon-developed concept "Chromatic Aberration Free". With the Nikon CF optical system the chromatic difference of magnification in the objective and eyepiece is individually corrected. This is unlike conventional microscopes where the corrections of such aberration has been, for the most part, compensated for in the objectives and eyepiece as a pair. As a result the Nikon Microscope OPTIPHOT has no orange colored fringe in the eyepiece.
In cooperation with the other optimum aberration corrections such as the Nikon Integrated Coating, a uniformly sharp image, much superior in resolution, contrast and color rendition is achieved over 100% of the effective, even, super-wide field of view, for observation as well as color photomicrography.

1. Objectives

In every case use the CF objectives in combination with the CF eyepieces.

The CF objectives to be used exclusively for the metallurgical microscope are designed for a mechanical tubelength of 210mm (this is longer than 160mm of the biological microscopes), and the parfocal distance 45mm (this is longer than 33.6mm of earlier type microscopes) to afford the optical designer a wide freedom for full correction of aberrations.
The indication "M" represents the brightfield use, and "BD" (Bright/Dark), the bright- and darkfield use, with the metallurgical microscope.
The BD objectives have an attaching diameter to the revolving nosepiece different from that of the M objectives.
"LWD" indicates the long working distance type.

1) Types

(1) M Plan Achromat (CF M Plan)
This type objectives whose chromatic correction is based on the line C (red) and F (blue), have been designed for brightfield use with the metallurgical microscope. Sufficient correction of all the aberrations, not only for the center but also for the periphery of viewfield, offers a flat image of high resolution with minimum flare over the whole area of viewfield. Thus, focusing at the center means simultaneously that at the marginal part of even ultra-wide image field.
The objectives are suited for ultra-wide observation and photomicrography.
The working distance of 5×, 10×, 20×, 40× and 100× (dry) objectives, relatively long for Plan types, provides great convenience in manipulation.

(2) M Plan Apochromat (CF M Plan Apo)
The highest class metallurgical objectives for brightfield microscopy. Thanks to the use of fluorite and special, low color dispersion glasses, etc. the color correction has been attained so far over the entire range of light waves including the line g (violet), along with the lines C (red) and F (blue).
Having quite a large numerical aperture, nevertheless providing the resolution, contrast and flatness of image, especially color reproducibility secured to an ideal degree over the whole area of viewfield, the objectives fulfill the requirements for color photomicrography.

(3) BD Plan Achromat (CF BD Plan)
Designed specifically for bright and darkfield observation with the metallurgical microscope. The correction of chromatic aberrations is accomplished to the same degree as with the M Plan Achromat.
Owing to their image flatness, high definition and minimum flare up to the periphery of viewfield, the objectives are also excellent for photomicrography.
The BD Plan 5×, 10×, 20×, and 40× have a relatively long working distance (even 1mm for 40×) for a darkfield objective.
The BD objectives are provided with the screw-in diameter 26mm, pitch 0.76mm, differing from that of the M objectives.
The revolving nosepiece of the epi-bright/dark field illuminator "BD" can accept the CF M Plan, CF M Plan Apo objectives, etc.,

if the adapter (available as accessory) is used.

The darkfield observation, where no illuminating light directly enters the objective, thus the background looks quite dark, makes discernible even so minute structures, uneveness, scratches, etc. beyond the limit of resolving power of the objective, as not to be possible by the brightfield observation. Therefore, so far as the presence of finest particles or subjects is concerned, the darkfield illumination gives marked effect.

(4) **M Plan Achromat LWD (CF M Plan LWD)**

Brightfield metallurgical objectives with an exceedingly long working distance. The correction of chromatic and other aberrations is attained to the same extent as with the M Plan Achromat, providing a high definition image with minimum flare up to the periphery of viewfield.

Owing to their long working distances (6mm with 20× and 3mm with 40×), they are especially suited for inspection of IC and micromanipulation, etc.

2) Use of the objective

(1) Oil immersion objectives (Oil)

The objectives discriminated by the engraving "Oil" are to be immersed in oil between the specimen and front of the objective. The use of the oil immersion objective whose N.A. is 1.0 or higher, is necessary for ensuring a high resolution such as is not possible with a dry system objective.

To see if air bubbles are present in the immersion oil, which deteriorate the image quality, pull out the eyepiece from the eyepiece tube to examine the objective exit pupil inside the tube.

To remove air bubbles, revolve the nosepiece slightly to and fro several times, apply additional oil, or replace the oil.

Be careful not to rotate the nosepiece too far as to soil the ends of the other objectives with oil.

To clean off the oil, pass lens tissue or soft cloth moistened with xylene lightly two or three times over the lens. It is essential at this time to avoid touching the lens with the part of tissue or cloth once used. Any remnants of oil left on the lens deteriorate the image quality.

(2) Coverglass

With the objectives engraved "210/0", neither a coverglass nor any other material should be placed on the specimen surface, because this will deteriorate the resolution and image contrast.

2. Eyepieces

To take full advantage of the CF eyepieces, use them in combination with the CF objectives. The indication "CF" should serve to prevent their use with other type objectives.

1) CFW eyepieces (CFW)

Being of wide field and high eyepoint type, the CFW eyepieces with diopter ring are only used for observation.

They are equipped with a rubber eyeguard.

An eyepiece called CFW 10×M, incorporating a photo mask, is also available, which enables focusing and framing by the use of the observation tube of the Trinocular Eyepiece Tube "T"

2) CFUW eyepiece (CFUW)

Featuring extra-wide field of view and high eyepoint, this eyepiece with diopter ring is designed exclusively for observation. It enables observation over a field of view twice as large as that of the ordinary type eyepieces in combination with the ultra-wide tube.

An eyepiece called CFUW 10×M, incorporating a photo mask, is also available, which enables focusing and framing by the use of the observation tube of the Ultra Wide Eyepiece Tube "UW"

3) CF Photo eyepieces (CF Photo)

Exclusively designed for photomicrography. Do not use them for observation.

Every eyepiece is liable to gather dirt and dust, which not only appear as shadows but also impair image quality and contrast.

Keep the eyepieces clean at all times.

3. Illumination Systems

1) Epi-brightfield illumination system (Fig.25)
The optical system for illumination in Metallurgical Microscope OPTIPHOT is constructed to fulfill the Koehler illumination requirements perfectly, and offers a bright, uniform field without any change-over manipulation.
As a light source, a 6V, 20W halogen lamp of long life is employed, which enables also ultra-wide field observation. Equipped with four most frequently used filters to be selected at the user's disposal. (See Table 1)

Generally, use the L filter (diffuser), but remove it out of the optical path, when centering the lamp.

2) Epi-bright/darkfield illumination system (Fig. 26)
The episcopic bright/darkfield illumination system for the Episcopic Bright/Darkfield Microscope OPTIPHOT permits convenient use, providing a bright and high contrast darkfield illumination without flare, and enabling also ultra-wide microscopy.

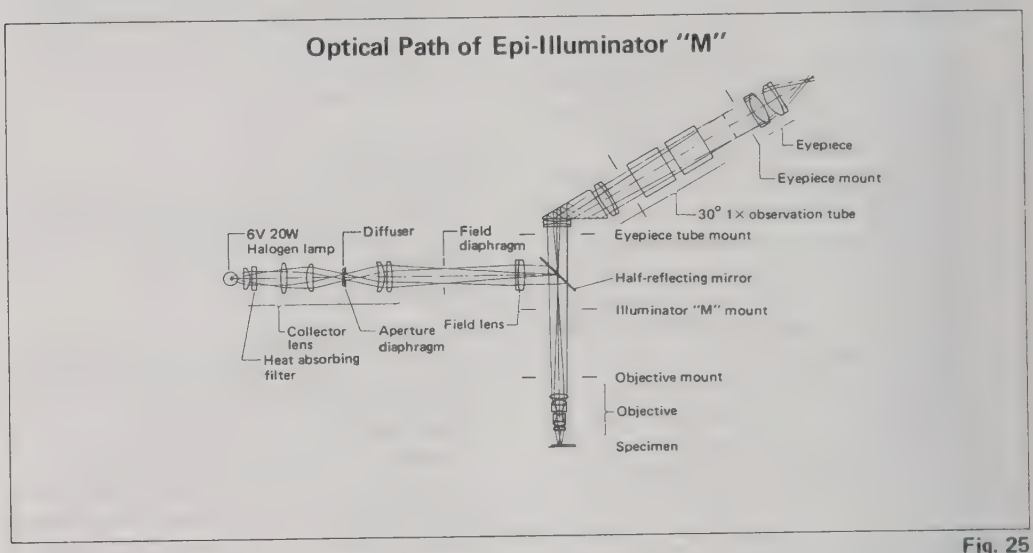


Fig. 25

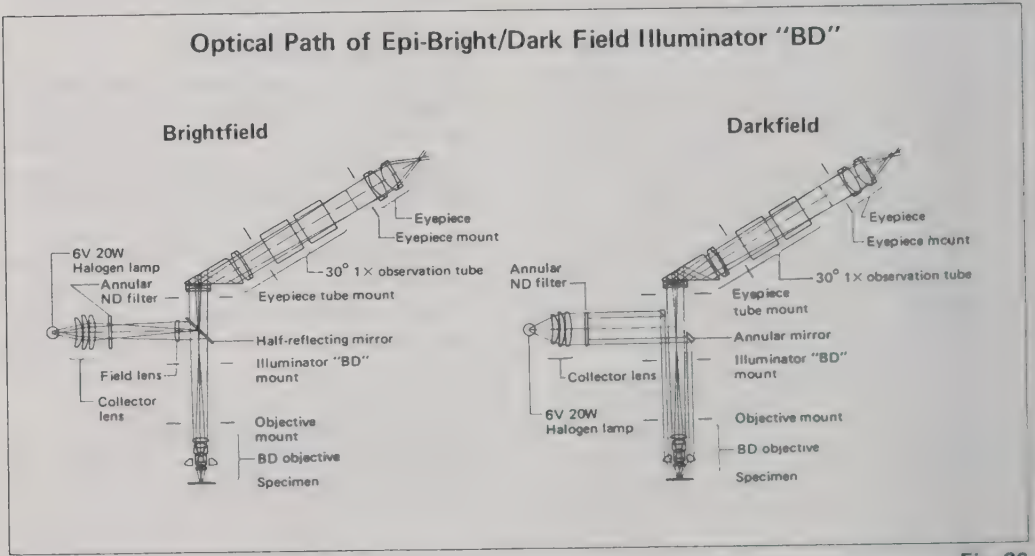


Fig. 26

5. Combination of Objectives and Eyepieces

Table 3.

CF Objectives (210/45) for Metallurgical Microscope						CF Eyepieces											
						Ordinary viewfield									Ultra-Wide viewfield		
						CFW 8× Field number 18 (Now in preparation)			CFW 10× Field number 18			CFW 15× Field number 14			CFUW 10× Field number 26.5		
Type	Magnification	Numerical aperture N.A.	Working distance W.D.mm	Focusing distance f mm	Resolving power μm	Total magnification M	Real viewfield φmm	Depth of focus μm	Total magnification M	Real viewfield φmm	Depth of focus μm	Total magnification M	Real viewfield φmm	Depth of focus μm	Total magnification M	Real viewfield φmm	Depth of focus μm
M Plan Apochromat	50×	0.9	0.22	4.2	0.31	400×	0.36	0.7	500×	0.36	0.7	750×	0.28	0.6	500×	0.5	0.7
M Plan Achromat	5×	0.1	20.0	37.6	2.8	40×	3.6	63	50×	3.6	56	75×	2.8	47	50×	5.3	56
	10×	0.25	9.0	21.2	1.1	80×	1.8	12	100×	1.8	10	150×	1.4	8.2	100×	2.7	10
	20×	0.4	3.0	11.6	0.69	160×	0.90	4.0	200×	0.90	3.5	300×	0.70	2.9	200×	1.3	3.5
	LWD 20×	0.4	6.0	10.1	0.69	160×	0.90	4.0	200×	0.90	3.5	300×	0.70	2.9	200×	1.3	3.5
	40×	0.65	1.0	5.3	0.42	320×	0.45	1.3	400×	0.45	1.2	600×	0.35	1.0	400×	0.66	1.2
	LWD 40×	0.55	3.0	5.2	0.50	320×	0.45	1.7	400×	0.45	1.6	600×	0.35	1.3	400×	0.66	1.6
	60×	0.8	0.30	3.7	0.34	480×	0.30	0.8	600×	0.30	0.7	900×	0.23	0.6	600×	0.44	0.7
	100×	0.9	0.30	2.1	0.31	800×	0.18	0.5	1000×	0.18	0.5	1500×	0.14	0.4	1000×	0.27	0.5
	Oil 100×	1.25	0.23	2.2	0.20	800×	0.18	0.5	1000×	0.18	0.4	1500×	0.14	0.4	1000×	0.27	0.4
BD Plan Achromat (for bright/darkfield)	5×	0.1	9.0	37.6	2.8	40×	3.6	63	50×	3.6	56	75×	2.8	47	50×	5.3	56
	10×	0.25	3.0	21.2	1.1	80×	1.8	12	100×	1.8	10	150×	1.4	8.2	100×	2.7	10
	20×	0.4	2.0	11.6	0.69	160×	0.90	4.0	200×	0.90	3.5	300×	0.70	2.9	200×	1.3	3.5
	40×	0.65	1.0	5.3	0.42	320×	0.45	1.3	400×	0.45	1.2	600×	0.35	1.0	400×	0.66	1.2
	(Now in 60× preparation)	0.8	0.35	3.7	0.34	480×	0.30	0.8	600×	0.30	0.7	900×	0.23	0.6	600×	0.44	0.7
	(Now in 100× preparation)	0.9	0.39	2.1	0.31	800×	0.18	0.5	1000×	0.18	0.5	1500×	0.14	0.4	1000×	0.27	0.5

Resolving power: $\frac{\lambda}{2\times N.A.}$ (λ =0.55 μm standard wavelength)

Depth of focus: $\frac{n\times\lambda}{2\times(N.A.)^2}+\frac{n}{7\times N.A.\times M}$ (Resolving power of eye = 2'
n : Refractive index of object side)

VI. PHOTOMICROGRAPHY

The Metallurgical Microscope OPTIPHOT is designed with particular care to assure the finest photomicrographs. Although various types of Nikon photomicrographic attachments (Microflex) are mountable, it is especially recommended that the Microflex Model HFM be used.

1. Combination of CF Objectives and CF Eyepieces

The combined use of the CF objectives and CF eyepieces is essential.
For the same total magnification, select a combination of the highest possible objective power and lowest possible eyepiece power to achieve the utmost image definition and contrast.

2. Checking the Illumination

Unevenness in the illumination will show up more conspicuously in photomicrography than in observation. Consequently, before taking a photograph, recheck the centering of the lamp.

3. Selection of Voltage and Filter

The color temperature of the light source varies with the voltage being used. Therefore, in color photomicrography, the selection of voltage and filter is essential (for the result to be obtained).

1) Selection of voltage and filter
Refer to the Table 4:

Table 4. Selection of Voltage and Filter

Film	Voltage (transformer)	Filter
Color film (Daylight type)	6	NCB 10 is to be used
Monochrome film	6	GIF filter, etc. is usable

The NCB 10 filter is most suitable for a standard film. Depending upon the make of the film, different color renditions may result.
It is recommended that in addition to the NCB 10 filter a color compensation filter (CC filter), available from the film manufacturer, be used.
For monochrome photomicrography, use such filters as GIF for contrast adjustment.

4. Shutter Speed

Favorable shutter speeds will be 1/4 ~ 1/15 sec.
For color photography, adjust the brightness not by changing the transformer voltage, but by selecting the ND filters (available as accessory).

5. Manipulation of Field and Aperture Diaphragms (For Epi-Illuminator "M")

In photomicrography, the adjustment of the field diaphragm is important for the purpose of limiting extraneous light which causes flare in the microscope image. Stop down the diaphragm so as to get an illuminated area slightly larger than that of the picture field.
By adjusting the aperture diaphragm, a change of depth of focus, contrast and resolution of image are attainable. Select a size suited to the purpose.
Generally speaking, the aperture diaphragm, is properly stopped down to 70 ~ 80% of the aperture of the objective being used.

6. Focusing

For focusing, refer to Table 5.

Table 5. Focusing

	Focusing with 10× or higher objective	Focusing with 5× or lower objective
"F" tube	Use Microflex finder	Use Microflex finder + Focusing telescope
"T" or "UW" tube	Use observation tube	Use observation tube or Microflex finder + Focusing telescope

1) For focusing with the Microflex finder
Refer to the instruction manual for the Nikon Microflex.

2) Focusing with the observation tube

For focusing with the observation tube of eyepiece tube "T" or "UW" for photomicrography, use the eyepiece incorporating the photo mask. Before proceeding to focusing, the binocular diopter adjustment should have been finished.

(1) Insert the eyepiece with photo mask into the eyepiece sleeve on the side of the user's dominant eye, and the viewing eyepiece into the other side sleeve.
Turning the diopter ring, bring the double crosshair in the mask eyepiece into sharp focus, and then, turning the coarse-fine focus knob, focus the specimen image onto the focused surface at the center of the mask. For diopter adjustment in the other eyepiece, do not manipulate the focus knob, but the diopter ring to bring the image into focus, with the objective 5× or 10×.

(2) Turning the eyepiece as a whole, set it in such a position that the photo mask appears as shown in Fig. 27.

(3) Furthermore, when using a low power objective, place the focusing telescope over the mask eyepiece, thus constructing an eyepiece of higher magnification, to perform precise focusing.

3) Magnifications of CF Photo eyepieces suitable for frame size of photo mask

Refer to Table 6.

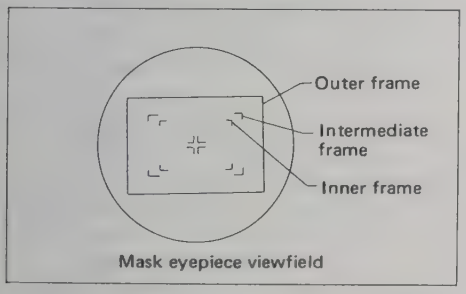


Fig. 27

Table 6. Magnifications of CF Photo Eyepieces Suitable for Frame Size of Photo mask

	Type of film	Magnification of photographic lens	Magnification of photo eyepiece
Outer frame	35mm	0.5×	5×
	3¼" × 4¼"	1.25×	
	6 × 9		
	4" × 5"		8×
Intermediate frame	35mm	0.5×	8×
	3¼" × 4¼"	1.25×	
	6 × 9		
	4" × 5"		10×
Inner frame	35mm	0.5×	10×
	3¼" × 4¼"	1.25×	
	6 × 9		

8. Vibration-free Operation and Photo Support Bracket

Set the microscope on a vibration-resistant, rigid desk or a bench with a vibration-proof device. Also use the photo support bracket.

9. Others

For the use of other photomicrographic attachments refer to the pertinent instruction manuals.

VII. USE OF THE ACCESSORIES

1. Ultra Wide Eyepiece Tube "UW"

1) CF M Plan Achromat 5× ~ 100×, CF M Plan Apochromat 50× and CF BD Plan Achromat 5× ~ 100× are used.

2) Assembly and microscopy are the same as those of the brightfield or bright/darkfield microscopy.

3) Focusing for photomicrography is possible with the observation tube, using the CFUW eyepiece incorporating the photo mask.

2. Polarizing Filter Set "PR"

The device is usable with the Epi-Illuminator "M" but not with the Epi-Bright/Dark Field Illuminator "BD".

1) Nomenclature (Fig. 28)

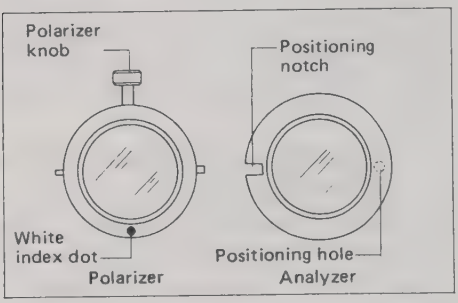


Fig. 28

2) Assembly (Fig. 29)

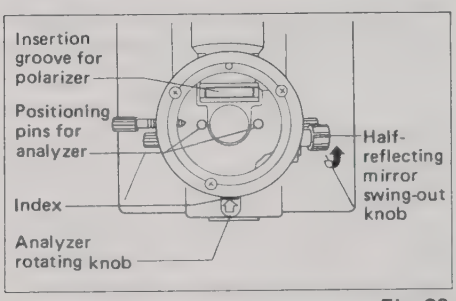


Fig. 29

(1) Inserting the polarizer

① Remove the trinocular tube, and set the analyzer rotating knob to the index. To swing out the half-reflecting mirror from the optical path, rotate the swing-out knob clockwise.

② Holding the polarizer knob, place the polarizer into the insertion groove, facing the white index dot toward the mirror.

Insertion and removal of the polarizer should be made with the half-reflecting mirror brought out of the optical path, for fear of damaging the mirror.

(2) Inserting the analyzer

① Insert the analyzer to the illuminator "M", fitting its positioning notch and hole to the pins on the illuminator.

It is attachable with the notch faced either right or left.

② Turning the half-reflecting mirror swing-out knob counterclockwise, bring the mirror into the optical path. Mount the trinocular tube.

3) Microscopy

(1) Be sure that the half-reflecting mirror has been set in the optical path. (Refer to P.10 1. - 1))

(2) Turn ON the power switch on the transformer to light the lamp, and set the power voltage meter to 4 or 5.

(3) Rotate the analyzer rotating knob to the rightside limit.

(4) Place the specimen on the stage plate and focus on the specimen with 10× objective.

(5) Adjust the interpupillary distance and diopter. (Refer to P.11 (2), (3))

(6) Make sure of the correct illumination. (Refer to P.10 1. - 5))

(7) Insert the filters to be used.
Insert the L filter, and for general microscopy add the NCB 10 filter and ND 16 filter.

(8) Swing in the objective to be used and refocus on specimen.

(9) Coincide the arrow mark on the analyzer rotating knob to the index to create the "Crossed Nicols".

(10) Adjust the brightness by means of the lamp voltage. If the image is found too dark with an objective of 40× or higher, remove the L filter.

(11) Adjust the aperture and field diaphragms. (Refer to P.12 (5), P.13 (6))

The analyzer, rotatable about 2° to the left and 45° to the right from the position of Crossed Nicols, where the arrow mark on the analyzer is coincided with the index, permits the adjustment according to which type of observation is to be made and what type of specimen, observed.

Note also that the position of Parallel Nicols is not obtainable by the rotation of the analyzer. For such a position, remove the analyzer.

VIII. TROUBLE SHOOTING TABLE

Although nowhere the user can find any disorder or derangement in the instrument, if he encountes some difficulty or dissatisfaction, recheck the use, referring to the table below:
The causes marked ◉ will take place only with the Epi-Illuminator "M".

1. Optical

Failures	Causes ——→	Actions
Darkness at the periphery or uneven brightness of viewfield (No appearance of viewfield)	• Optical path in trinocular tube not fully changed-over	Changing-over to the limit (Refer to P. 11, 16)
	• Optical path in the illuminator not fully changed-over	Changing-over to the limit
	• Revolving nosepiece not in click-stop position (Objective not centered in optical path)	Revolve it to click-stop position
	• Lamp bulb not centered	Centering (Refer to P. 10, 14)
	◉ Field diaphragm too much closed	Open it properly
	• Dirt or dust on the lens (Objective, eyepiece, specimen)	Cleaning
	◉ L filter not set in or incorrectly positioned	Correct positioning (Refer to P. 8)
	• Revolving nosepiece not correctly attached	Correct attaching (Refer to P. 9)
Dirt or dust in the viewfield	• Dirt or dust on the lens (Objective, eyepiece)	Cleaning
	• Dirt or dust on the specimen	Cleaning
No good image obtained (low resolution or contrast)	• Specimen with coverglass observed	Remove coverglass
	◉ Immersion oil soils the top of dry system objective (especially 40×)	Cleaning
	• Dirt or dust on the lens (Objective, eyepiece, specimen)	Cleaning
	◉ No immersion oil used on immersion system objective	Use immersion oil (Refer to P. 18)
	◉ Air bubbles in immersion oil	Remove bubbles
	◉ Not specified immersion oil used	Use Nikon immersion oil
	• Incorrect illumination	Correct the illumination (Refer to P. 10, 14)
	• Dirt or dust on the entrance lens	Cleaning
Image quality deteriorated	◉ Aperture diaphragm too much closed	Open properly (Refer to P. 12)
	◉ L filter not inserted	Insert it in correct position (Refer to P. 8)
One side dimness of image	• Specimen placed on the stage tilted	Make it parallel to the stage
	• Revolving nosepiece not in click-stop position	Revolve it to click-stop position

Failures	Causes →	Actions
	• Revolving nosepiece not correctly attached →	Insert it to the limit and clamp it firmly
	• Revolving nosepiece not clamped →	Clamp tightly
	• Objectives not attached securely →	Screw in securely
Image moves while being focused	• Specimen rises from stage surface →	Place it stable
	• Revolving nosepiece not in click-stop position →	Revolve it to click-stop position
	• Revolving nosepiece not clamped →	Clamp tightly
	• Objectives not attached securely →	Screw in securely
	• Lamp bulb not correctly centered →	Correct centering (Refer to P. 10, 14)
Image tinged yellow	• NCB 10 filter not used →	Use NCB 10 filter
	• Too low power source voltage →	Raise the voltage on the transformer
Too bright image	• ND filter not used →	Use ND filter

2. Manipulation

Failures	Causes →	Actions
High power objective touches the specimen, when changed-over from low power	• Eyepiece diopter not adjusted →	Diopter adjustment (Refer to P. 11, 15)
Insufficient parfocality of objective (when changed-over)	• Eyepiece diopter not adjusted →	Diopter adjustment (Refer to P. 11, 15)
Movement of image not smooth by moving the specimen	• Specimen holder not tightly fixed →	Fix it tightly
No fusion of binocular images	• Interpupillary distance not adjusted →	Adjustment (Refer to P.11, 15)
Fatigue of observing eyes	• Incorrect diopter adjustment →	Correct adjustment (Refer to P.11, 15)
	• Inadequate brightness of illumination →	Use ND filter or change power voltage

3. Electrical

Failures	Causes ⟶	Actions
Lamp does not light even though switched ON	• No electricity obtained	⟶ Connect the cord to socket
	• No lamp bulb attached	⟶ Attaching
	• Lamp bulb blown	⟶ Replacement
	• Fuse blown	⟶ Replacement
Unstable brightness of illumination	• House current voltage fluctuates too much	⟶ Use transformer or the like (for adequate voltage)
Lamp bulb promptly blown	• Not specified lamp bulb used	⟶ Use 6V 20W specified bulb: (Halogen bulb: PHILIPS 7388)
	• Too high voltage of house current	⟶ Use transformer for adjustment
Insufficient brightness of illumination	• Lamp bulb not centered	⟶ Centering (Refer to P. 10, 14)
	◉ Aperture too much closed	⟶ Open it properly (Refer to P.12)
	• Not specified lamp bulb used	⟶ Use 6V 20W specified bulb: (Halogen bulb: PHILIPS 7388)
	• Dirt on lens (Objective, eyepiece, filter)	⟶ Cleaning
Fuse blown	• Not specified fuse used	⟶ Use 1A (250V) or 0.5A (250V)
Flickering or unstable brightness of lamp bulb	• Lamp bulb going to be blown	⟶ Replacement
	• Connector not connected securely	⟶ Secure connection
	• Fuse holder not firmly fastened	⟶ Firm fastening
	• Irregular change of house current voltage	⟶ Use stabilizer
	• Lamp bulb insufficiently inserted into the socket	⟶ Positive connection

4. Photomicrography

Failures	Causes ⟶	Actions
No sharp picture obtained	• Improper focusing ⟶	• Viewing into the finder and turning diopter ring, bring double crosshair into focus. Moving the eye laterally, rotate fine focus knob, until no parallax separation appears between the image and double crosshair. • At lower magnifications use focusing telescope in addition.
	• Out of focus (Especially with high power objective and long-exposure) ⟶	• For preventing external vibration, use vibration-proof table or rigid desk. • Select a place free from vibration, such as caused by traffic, passers-by or motors etc.
	• Momentary vibration ⟶	• Using ND filters or others, elongate exposure time (for color film, to 1/4 ~ 1/15 sec.) • Lower the voltage, and elongate exposure time (for black-and-white film). Note, however, for color film, that lowering of color temperature and change of spectral characteristics will be unavoidable. • Use photomicrographic stand and separate camera from microscope to prevent transmission of vibration.
	• Specimen with coverglass observed ⟶	• Remove coverglass
Fogging of image	• Grease, dust or dirt on optical surfaces ⟶	• Clean the front of objective thoroughly, top surface of photo eyepiece, specimen, photographic lens, etc.
Illuminated image not uniformly	• Inadequate adjustment of illumination (This shows up more conspicuously in photography than in observation) ⟶	• Adjust illumination properly (Refer fo P.10, 14)
Insufficient image contrast	◉ Aperture diaphragm opened too large. ⟶	• Generally, good results will be achieved with aperture stopped down to 70 ~ 80% of N.A. of the objective being used. (Refer to P. 22 5.)
	• Incorrect use of filter ⟶	• Use of a GIF filter will increase contrast.
	◉ Inadequate use of field diaphragm ⟶	• Stop down field diaphragm to a diameter slightly larger than the diagonal of picture frame. (Refer to P. 22 5.)
	• Low contrast in specimen ⟶	• To increase contrast optically, select darkfield or differential interference methods. • In black-and-white photography, for low contrast specimens a film of finer grain and higher contrast is more suited (such as minicopy film).

Failures	Causes ⟶	Actions
		• For general specimens a film of wider latitude and finer grain is preferable.
Deficient resolving power of microscope	• Insufficient N.A. of objective ⟶	• Use a large N.A. objective. • For the same magnification, increase power of objective rather than that of eyepiece to attain higher resolution and sharpness.
	• Excessive magnification ⟶	• 500 ~ 1000 times N.A. are magnification limits for resolving power.
Ghosts or flare appears	• Extraneous light entering the ocular finder ⟶	• Darken the surroundings or place the cap on the ocular finder.
	• Stray light entering ⟶	• Take care not to expose microscope and specimen to direct sunlight and other intense lights.
Poor photograph obtained	• Inadequate use of filter ⟶	• Use NCB 10 filter.
	• Film of another make or emulsion NO. ⟶	• Note that, when using a daylight film, remarkably different spectral sensitivities will result depending upon the types, make, etc. • Even though of same make, according to emulsion number, different color rendition will be obtained.
	• Wrong power source voltage used ⟶	• Take picture in every case at the specified voltage. (Refer to P. 22 Table 4)
	• Incorrect exposure time ⟶	• By inadequate exposure time, color rendition will not be true on account of "reciprocity law failure" • Then, with the help of exposure time indicator, adjust exposure time according to characteristics of film by means of ND filters, or compensate for such failure by means of CC filters. (Refer to Kodak Data)
	• Influenced by film development ⟶	• Especially, for making color prints, it is recommended to contact the development laboratory.

ELECTRIC SPECIFICATIONS

Power source (Transformer)	100V 120V 50/60 Hz 220/240V
Transformer (Secondary voltage)	3 – 4 – 5 – 6 V
Halogen lamp	6V 20W (PHILIPS 7388)
Fuse	100V, 120V } 1A (250V) 220/240V 0.5A (250V)

We reserve the right to make such alterations in design as we may consider necessary in the light of experience. For this reason, particulars and illustrations in this handbook may not conform in every detail to models in current production.

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